



- 1 -

Endoscope apparatus

The present invention relates to an endoscope apparatus for detecting and treating affected parts in a body cavity, using microwaves.

5       A type of medical therapy is already known according to which an affected part such as a malignant tumor in a living body is heated to destroy the cells in this part. However, no effective means according to this therapy has been established yet. For example, a  
10   method for heating and treating the affected part in the body cavity is known. This method utilizes an air and water supply inlet and a suction outlet provided at the distal end portion of the endoscope. Warm air or water is blown on the affected part in the body  
15   cavity from this air and water supply inlet, while the warm air or water is exhausted from the suction outlet, in order to heat and treat the affected part. This method provides some therapy effect when the malignant tumor portion is exposed at the surface  
20   of the body. However, when the tumor lies deep in the body, the warm air or water blown against the vital tissues will stimulate the circulation of blood in the normal tissue at the surface of the cavity wall. The temperature rise in the tissues is thus suppressed  
25   and heat cannot be transferred to the deep portion, so that the therapy effect at the deep part may not be

obtained.

Another method employs conventional endoscopic high frequency surgical knives and endoscopic laser scalpels. But these instruments are essentially used to surgically remove the affected parts, so that accidental contact of such an instrument with normal tissue may destroy this tissue. If the high frequency output or the laser output is reduced to avoid such a danger, the self-protection function of the normal tissue described above prevents the energy from being transferred to the deep affected part, and thus a sufficient treatment effect is not obtained.

On the other hand, when the affected part in the body cavity is to be treated, the presence of the affected part and its position must be detected in advance. However, it has been conventionally impossible to continuously carry out detection and treatment of the affected part utilizing the various means described above. After the detecting means is inserted into the body cavity through a channel of the endoscope to detect the affected part, it is extracted from the channel and then a treating means such as a high frequency or laser scalpel is inserted through this channel to treat the affected part. Therefore, much time and labor is required for the detection and the treatment of the affected part, which results in poor operability. In addition, since the endoscope may shift in the body cavity when the affected part detected by the detecting means is treated by the treating means, the affected part cannot be reliably treated.

The afore-mentioned detecting means utilizes for detection of the affected part the fact that the temperature of the affected part such as cancer or a tumor in the vital tissues is higher by about  $1^{\circ}\text{C}$  than that of normal tissue. For example, a probe for measuring temperature is inserted into the channel and then pressed against the inner surface of the body cavity to

measure the temperature thereof, or a liquid crystal membrane is pressed against the inner surface of the body cavity and the variation in color of this membrane is observed to determine the temperature.

5           However, since these detecting means utilize heat conduction through contact, only the temperature at the surface of the body can be measured and therefore an affected part lying below the mucous membranes cannot be precisely detected. It is, of course, entirely  
10 impossible to find an affected part in the pancreas or the liver into which the detecting means cannot be inserted.

          In summary, it has been conventionally difficult to detect and treat an affected part below the surface  
15 of the body cavity or to continuously perform these detection and treatment operations easily and rapidly.

          It is an object of this invention to provide an endoscope apparatus for rapidly and continuously carrying out detection and treatment of an affected part in a  
20 body cavity.

          According to this invention, the distal end portion of the endoscope is provided with a microwave antenna for detecting microwaves radiated from the vital tissues and for radiating microwaves to the vital tissues. The  
25 affected part is detected based on the level of intensity of the microwaves radiated from the vital tissues, and is treated by microwaves radiated on the detected affected part.

          This invention can be more fully understood from  
30 the following detailed description when taken in conjunction with the accompanying drawings, in which:

          Fig. 1 shows a perspective view of an endoscope apparatus according to one embodiment of this invention;

          Fig. 2 is a view showing the internal structure of  
35 the endoscope apparatus shown in Fig. 1;

          Fig. 3 is a sectional view of the distal end portion of the same endoscope;

Fig. 4 is a sectional view of the distal end portion of an endoscope apparatus according to another embodiment of this invention; and

5 Fig. 5 is a view showing the general structure of the endoscope apparatus according to the embodiment of Fig. 4.

Referring to an endoscope apparatus as shown in Fig. 1, an endoscope 11 comprises an insertion tube 12 which is inserted into a body cavity, a control section 15  
10 having an angle knob 14 for bending a bending section 13 of this insertion tube 12, and an eyepiece section 16 for observing the interior of the body cavity. A connector 18 provided at the front end of a universal cord 17 extending from the control section 15 of the  
15 endoscope 11 is coupled to a socket (not shown) of a light supply unit 19. To the connector 18 is also connected a microwave transmitting and receiving device 21 (hereinafter referred to as the "microwave device") via a transmission line for passing a microwave current  
20 therethrough, for example, a coaxial cable 20. A display 22 is provided at this microwave device 21.

The schematic internal structure of the endoscope apparatus of Fig. 1 is shown in Fig. 2. As shown in this figure, an objective lens system 24 is provided at the  
25 distal end 23 of the endoscope 11, and an optical image guide 25 extends from the objective lens system 24 to an eyepiece lens 16a of the eyepiece section 16. A light guide 26 extends from the distal end 23 to the insertion tube 12 and through the universal cord 17 to the con-  
30 nector 18. The distal end 23 is provided with a microwave antenna 27 which is connected to the microwave transmission line (coaxial cable) 20. Referring now to Fig. 3 showing the structure of the distal end 23 in detail, the microwave antenna 27 is composed of an antenna  
35 rod 27a and a microwave reflector 27b surrounding the antenna rod 27a. The reflector 27b has a reflective inner surface 23a of parabolic shape and is made of

a metallic material for prevention of heat radiation.

Over the front opening of the reflector 27b is liquid-tightly fitted a protective membrane 27c which is made of a material having a low dielectric constant, for

5 example, vinyl chloride. The outer surface of the reflector 27b is covered with a cover 27d for preventing heat radiation and for insulation. This cover 27d is made of a high-heat-resistant insulating material of high strength, for example, epoxy resin, ceramic or the

10 like. The microwave antenna 27 thus constructed is fitted into and fixed in a recess 23a provided in the distal end 23. The cover 27d is not required if the distal end 23 is made of the same material as that of the cover 27d. The microwave antenna 27 is connected

15 to a core 20a of the coaxial cable 20. The light guide 26 is disposed adjacent to the microwave antenna 27, and the objective lens system 24 and the image guide 25 are juxtaposed to the light guide 26.

When the connector 18 is coupled to the light  
20 supply unit 19, the light guide 26 guides the light from a light source 30 in the light supply unit 19 into the body cavity. The light source 30 is operated and controlled by a lighting circuit 31. The microwave transmission line, i.e., the coaxial cable 20, is

25 connected to one input terminal of a switch circuit 32 of the microwave device 21. The output terminal of this switch circuit 32 is connected to the input terminal of a microwave receiver 33, the output terminal of which is connected to the input terminal of an arithmetic

30 circuit 34. The output terminal of the arithmetic circuit 34 is connected to the display 22. A power source 35 is connected to a cooler 36 and an oscillator 37 to supply power thereto. The cooler 36 is

disposed so as to cool an oscillating tube (not shown)

35 of the oscillator 37. The output terminal of the oscillator 37 is connected to the other output terminal of the switch circuit 32.

In the endoscope apparatus of this structure, when a switch 28 of the microwave device 21 is changed over to the reception side and the insertion tube 12 of the endoscope 11 is inserted into the body cavity, micro-  
5 waves generated from the tissues lying in the direction of the observation field of view of the eyepiece section 16 are received by the microwave antenna 27 at the distal end 23. These microwaves are input to the switch circuit 32 through the coaxial cable 20. The  
10 switch circuit 32 guides the microwaves as a microwave current to the microwave receiver 33, since the switch 28 has been changed over to the reception side. The microwave receiver 33 shapes the waveform of the microwave current, amplifies it, and then inputs it into the  
15 arithmetic circuit 34. The arithmetic circuit 34 calculates the temperature corresponding to the intensity of the microwaves i.e. the temperature of the vital tissues, on the basis of the microwave current. The temperature data obtained from this calculation is input  
20 to the display 22 for display. The affected part such as cancer or a tumor in the vital tissues has a temperature higher by 1°C than that of normal tissue. Therefore, when the high temperature is displayed on the display 22, the existence of an affected part in the direction of  
25 the field of view can be detected. When the affected part is detected, the switch 28 is changed over to the transmission side. Then, a microwave current in the oscillator 37 is guided into the coaxial cable 20 via the switch circuit 32. The microwave current in the  
30 coaxial cable 20 is supplied to the microwave antenna 27, and then microwaves are radiated from the microwave antenna 27 to the affected part. If the affected part lies deep beneath the wall of the body cavity, the affected part is irradiated with the microwaves through  
35 the normal tissue at the cavity wall surface. In this case, the temperature of the normal tissues is suppressed due to the simulated blood circulation caused by the

self-protective function of the body. However, the temperature in the affected part rises in correspondence with the microwave intensity, since the affected part has bad blood circulation. When this raised temperature reaches a predetermined value, the tissues of the affected part are destroyed by the heat and the affected part may be treated.

As described above, according to this invention, microwaves are used for detection and therapy of the affected part of the vital tissues in the body cavity. Microwaves are capable of being transmitted through vital tissues. Therefore, even if the affected part lies deep beneath the cavity wall, the microwaves radiated from the affected part penetrate through the normal tissues at the cavity wall surface and are received by the microwave antenna. In this manner, the deep affected part can be easily detected. Similarly, microwaves are also transmitted through the normal tissues and arrive at the deep affected part in the case of therapy. In the detection and treatment of the affected part, reception and transmission of the microwaves can be executed by merely changing over the switch, so that the apparatus has excellent operability and assures accurate radiation of the microwaves to the affected part after detection.

In the embodiment described above, the microwave antenna has been fixed to the distal end of the endoscope. However, it may be detachably provided at the distal end as shown in Fig. 4. In other words, the microwave antenna 27 is detachably screwed or snapped in the recess 23a of the distal end 23. When the antenna 27 is mounted in the recess 23a, it is connected to the coaxial cable 20. With such a construction, the antenna may be replaced by another of a given frequency band, so that microwaves may be received with high characteristics. In addition, the oscillator 37 in the microwave device 21 is provided with a tuner 38 as shown in Fig. 5,



and the microwaves oscillated from the oscillator 37 are adjusted in frequency.

5 In accordance with this structure, the frequency of the microwaves which can be received or oscillated can be varied according to the conditions of the affected part so that good detection and treatment thereof may be achieved.

10 Although a pole antenna is employed as the antenna 27 in the above embodiment, a dipole antenna may be used. Additionally, although the temperature was displayed by the display provided in the microwave device, the display may be provided in the field of view of the endoscope eyepiece section for performing temperature display. The display does not necessarily display the  
15 temperature; it is sufficient if the indication helps to differentiate the affected part from normal tissue.

## Claims:

1. An endoscope apparatus characterized by comprising:

an endoscope (11) having an insertion tube (12)  
5 which is inserted into a body cavity, a distal end  
portion (23) provided at a front end of said insertion  
tube (12), a microwave antenna (27) provided at said  
distal end portion for receiving biological radiant  
microwaves radiated with directivity from vital tissues  
10 in the body cavity and for radiating microwaves for  
treatment to the vital tissues with directivity, and  
a microwave transmission line (20) connected to said  
microwave antenna (27) for transmitting said microwaves  
for treatment;

15 means (33) for receiving said biological radiant  
microwaves transmitted through said microwave trans-  
mission line (20) to output a reception signal  
corresponding to the intensity of said biological  
radiant microwaves; and

20 displaying means (22) for processing said reception  
signal from said receiving means (33, 34) to display  
the condition of said vital tissues.

2. An endoscope apparatus according to claim 1,  
characterized in that said microwave antenna (27) is  
25 composed of an antenna rod (27a) and a reflector (27b)  
for providing directivity to said microwaves.

3. An endoscope apparatus according to claim 1 or  
2, characterized in that said microwave antenna (27)  
is detachably mounted to said distal end portion (23).

30 4. An endoscope apparatus according to claim 1,  
characterized in that said transmission line comprises  
a coaxial cable (20).

5. An endoscope apparatus according to claim 1, 2  
or 4, characterized in that reception and transmission  
35 of said microwaves are selectively changed over by  
switching means (32).

6. An endoscope apparatus according to claim 1 or 2, characterized in that said reception signal from said receiving means (33) is input into arithmetic means (34) for calculating and processing said reception signal to compute a temperature of the vital tissues corresponding to the microwave intensity and for inputting temperature data to said displaying means (22) for display.

7. An endoscope apparatus according to claim 2, characterized in that said reflector (27b) of said microwave antenna (27) has a parabolic reflective surface and a front opening, and a protective membrane (27c) is liquid-tightly fitted over said opening.

8. An endoscope apparatus according to claim 7, characterized in that said protective membrane (27c) is made of a material having a low dielectric constant.

9. An endoscope apparatus according to claim 7, characterized in that said protective membrane (27c) is made of vinyl chloride.

10. An endoscope apparatus according to claim 2 or 7, characterized in that said microwave antenna (27) has a cover (27d) provided on the outer surface of said reflector (27b), said cover being made of a high-heat-resistant insulating material of high strength.

11. An endoscope apparatus according to claim 10, characterized in that said cover (27d) is made of an epoxy resin.

12. An endoscope apparatus according to claim 10, characterized in that said cover (27d) is made of ceramic.

13. An endoscope apparatus characterized by comprising:

an endoscope (11) having an insertion tube (12) which is inserted into a body cavity, a distal end portion (23) provided at a front end of said insertion tube, a microwave antenna (27) provided at said distal end portion (23) for receiving biological radiant microwaves radiated with directivity from vital tissues

in said body cavity and for radiating microwaves for treatment to said vital tissues with directivity, and a microwave transmission line (20) connected to said microwave antenna to transmit said microwaves for treatment;

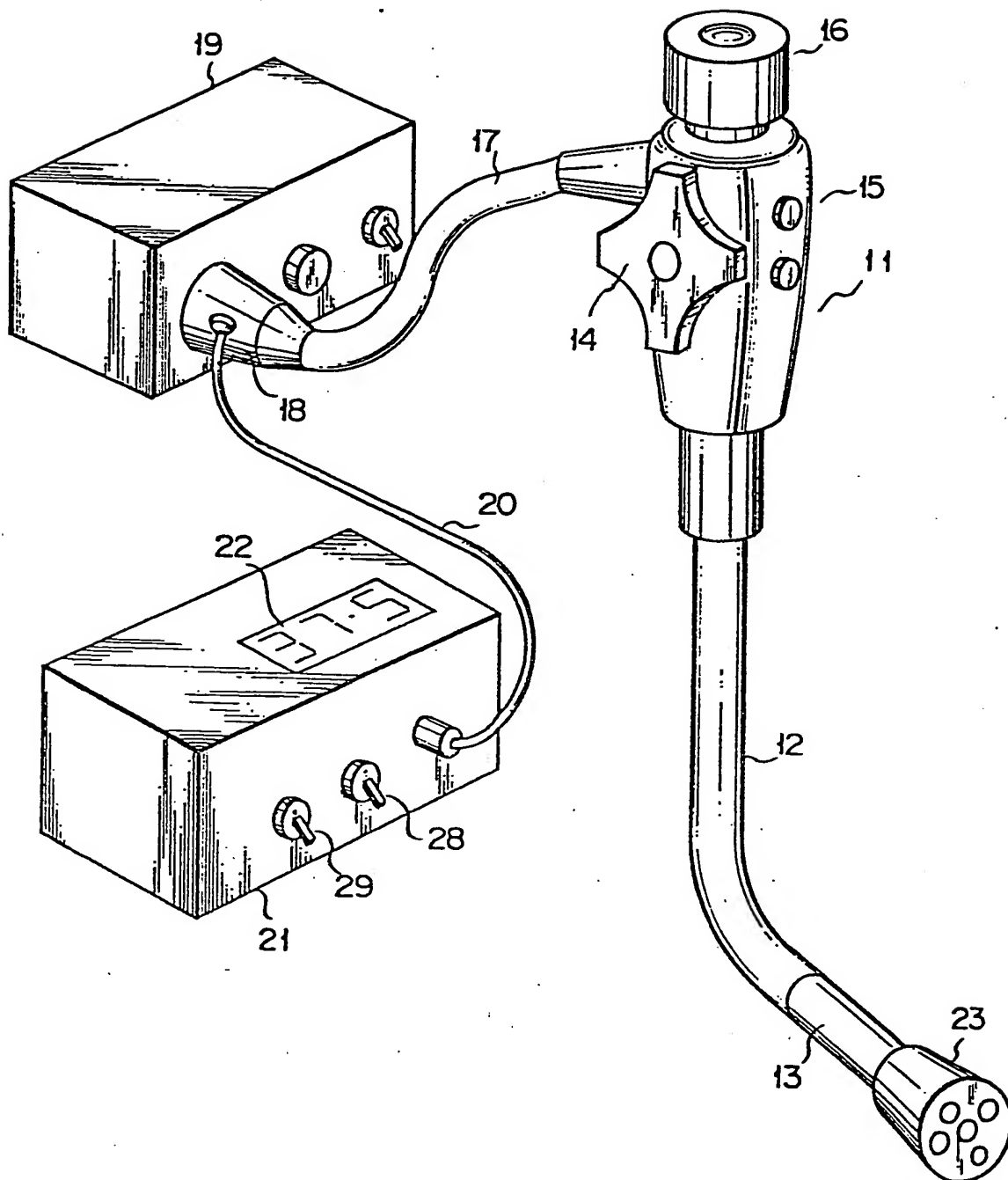
an oscillator (37) for oscillating to produce said microwaves for treatment;

means (33) for receiving said biological radiant microwaves to output a reception signal corresponding to the intensity of said biological radiant microwaves;

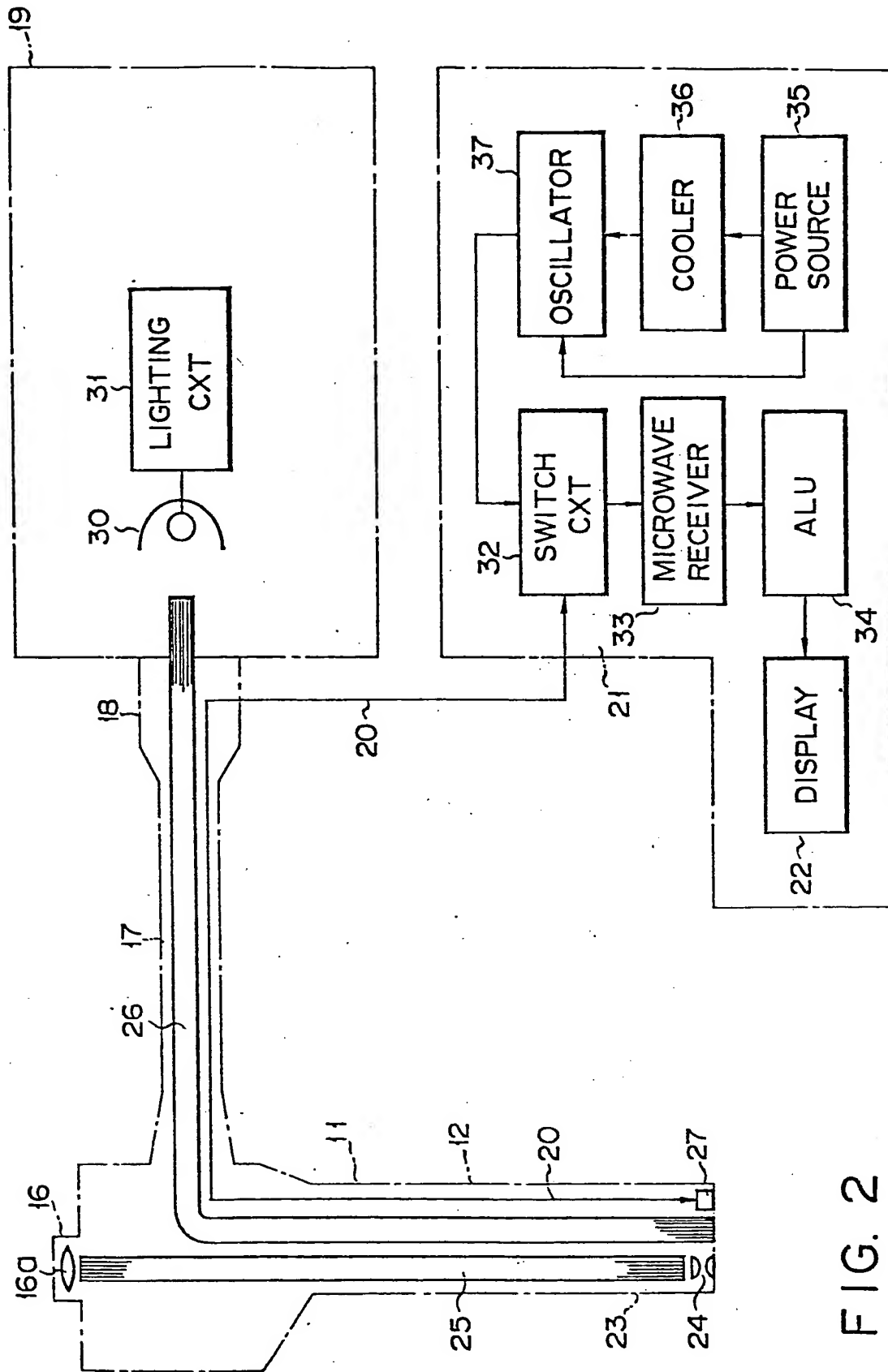
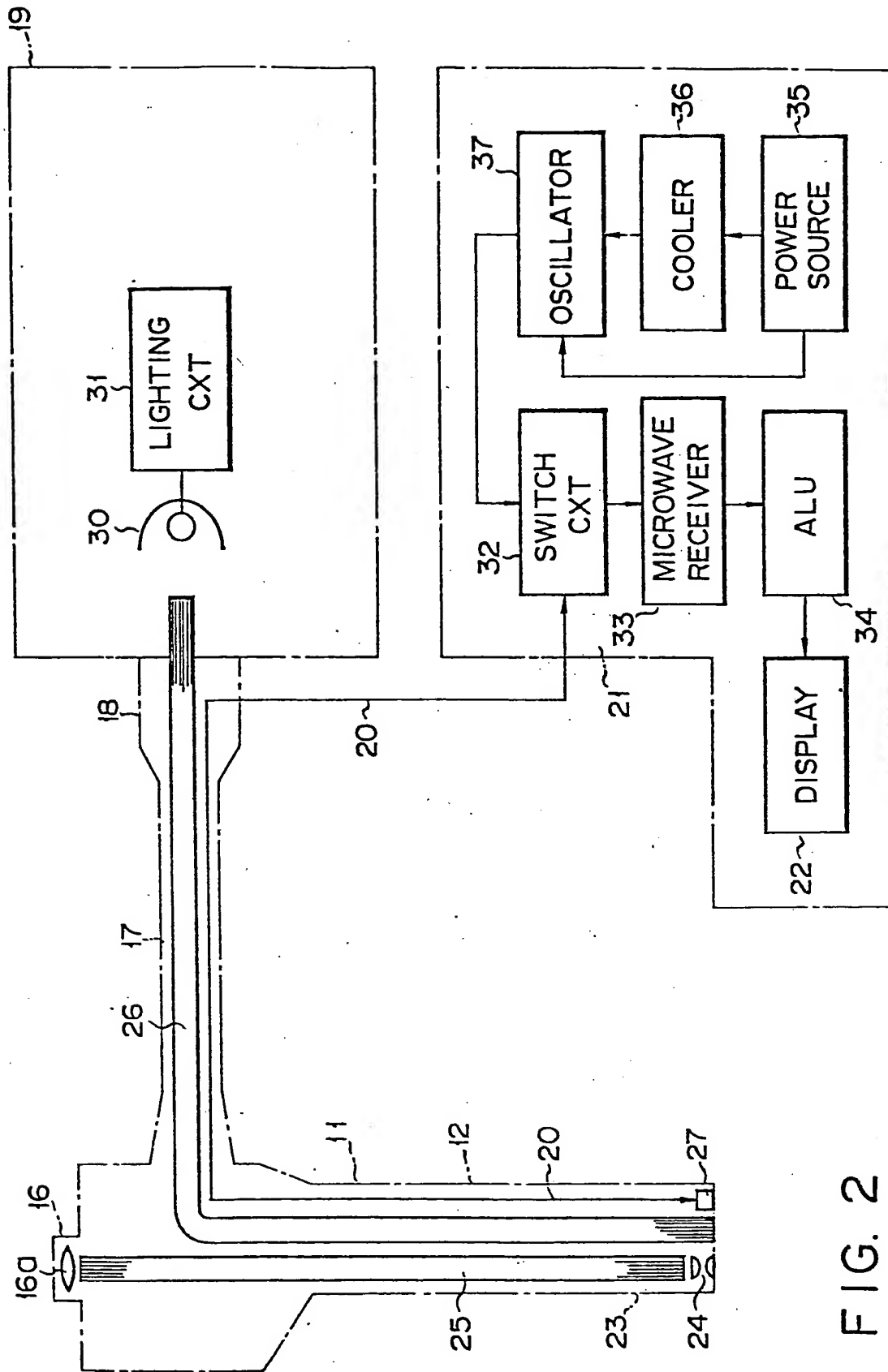
a switch circuit (32) connected to said oscillator (37) and said receiving means to selectively connect said oscillator or said receiving means through said microwave transmission line (20) to said microwave antenna (27);

arithmetic means (34) for processing said reception signal from said receiving means (33) and for calculating the temperature of the vital tissues corresponding to the intensity of said biological radiant microwaves to output temperature data; and

means (22) connected to said arithmetic means for displaying said temperature data.

114  
FIG. 1

2/4



3/4

FIG. 3

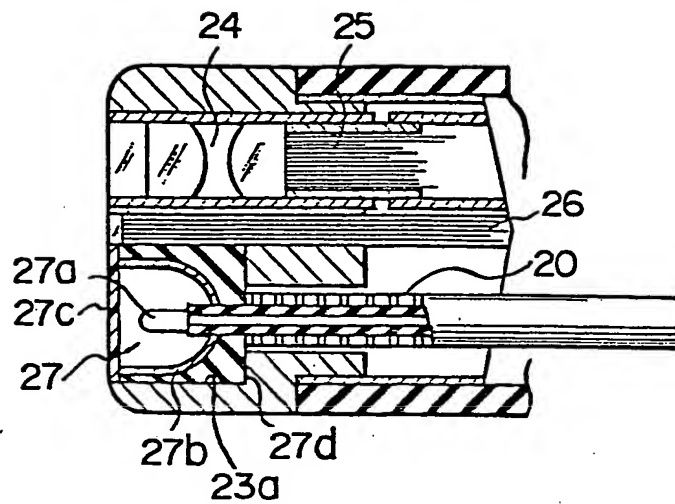
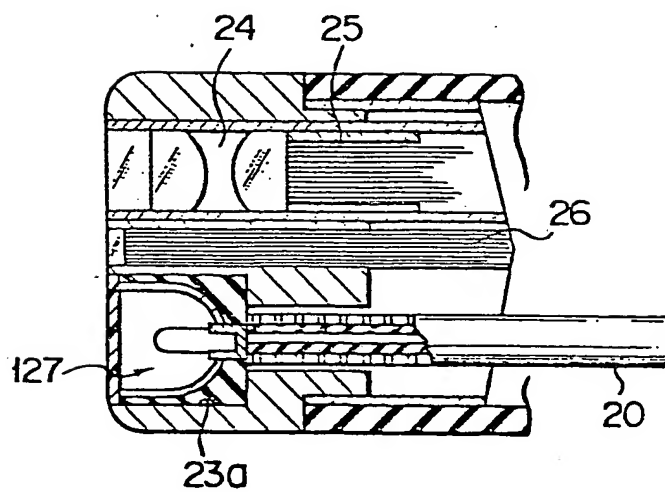


FIG. 4



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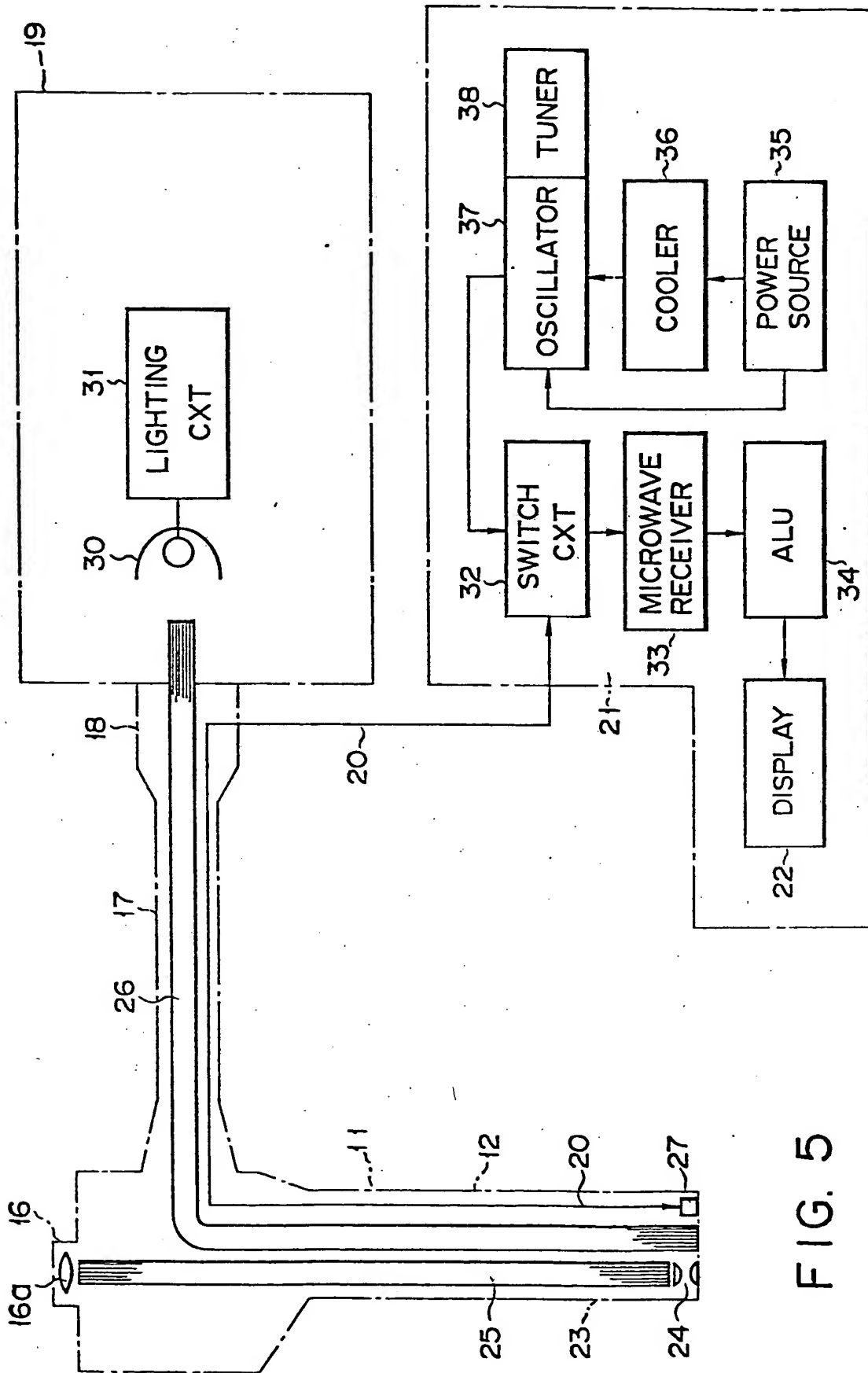


FIG. 5





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# EUROPEAN SEARCH REPORT

0048402

Application number

EP 81 10 7120

## DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.)
			TECHNICAL FIELDS SEARCHED (Int. Cl.)
X	<u>FR - A - 2 421 628 (CGR-MEV)</u> * Page 3, lines 12-20; page 3, line 32 to page 4, line 8; page 4, lines 27-29; page 6, lines 11-13 *	1,4-6, 13	A 61 N 5/02 A 61 B 1/00
	-- PROCEEDINGS OF THE IEEE, vol. 68, no. 1, January 1980 New Jersey, US L.S. TAYLOR "Implantable radiators for cancer therapy by microwave hyperthermia", pages 142-149 * Page 145, left-hand column, paragraphs 2-4; page 148, left-hand column, last paragraph and right-hand column, first paragraph *	1,2,4, 7	A 61 N 5/02 A 61 B 1/00 A 61 N 5/04 A 61 B 5/00 A 61 N 1/08
	-- IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, vol. IM-29, no. 2, June 1980, New York, US D.D. NGUYEN et al. "Combination of local heating and radiometry by microwaves", pages 143-144. * Page 143, first paragraph of the article and right-hand column, paragraphs 2,4 and figure 2 *	1,4,5, 13	
	-- <u>GB - A - 2 000 335 (RCA)</u> * Page 1, lines 113-125; page 2, lines 15-34; 39-46 and 87-91 *	1,4,5, 8,13	
The present search report has been drawn up for all claims			CATEGORY OF CITED DOCUMENTS
			X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
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# EUROPEAN SEARCH REPORT

0048402

Application number

EP 81 10 7120

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DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
	<u>CH - A - 254 655 (GRELL)</u> * Page 1, line 62 to page 2, line 29 *	2,7	
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	<u>US - A - 3 924 196 (TAKAHASHI)</u> * Column 2, lines 40-56 *	2,7	
	--		
	<u>FR - A - 2 269 356 (GUTTNER)</u> * Page 3, lines 28-30; page 6, lines 16-19, 28-30 *	7-9	TECHNICAL FIELDS SEARCHED (Int. Cl.)
	--		
PE	<u>DE - A - 3 012 150 (OLYMPUS)</u> * Page 8, lines 1-9; page 10, lines 1-15 and 31-39; page 11, lines 20-32; figure 8 *	1,2,5	
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A	<u>DE - A - 1 648 905 (GABRIEL)</u> -----		

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